

## CLAIMS

1           1.     A dynamic gain flattening filter configured to receive an  
2     optical signal, comprising:

3                 a first filter stage including,

4                 a first tunable coupling member;

5                 a first differential delay with first and second tunable delay paths;

6     and

7                 wherein the first tunable coupling member adjusts an amount of  
8     power of the optical signal divided onto the first and second tunable delay  
9     paths of the first differential delay.

1           2.     The filter of claim 1, wherein the first differential delay  
2     includes a fixed portion and a tunable portion.

1           3.     The filter of claim 1, wherein the first differential delay  
2     includes a first fixed differential delay and a first tunable differential delay  
3     with respect to the first and second tunable delay paths.

1           4.     The filter of claim 3, wherein the first fixed differential delay  
2     sets a periodic variation in a power spectrum of the optical signal.

1           5.     The filter of claim 3, wherein the first tunable differential  
2     delay sets a phase of the periodic variation in the power spectrum of the  
3     optical signal.

1           6.     The filter of claim 3, wherein the first fixed differential delay  
2     is positioned between the first tunable coupling member and the first tunable  
3     differential delay.

1           7.       The filter of claim 3, wherein the first tunable differential  
2       delay is positioned between the first tunable coupling member and the first  
3       fixed differential delay.

1           8.       The filter of claim 1, further comprising:  
2                   a second stage including:  
3                   a second tunable coupling member ;  
4                   a second differential delay with first and second tunable  
5       delay paths; and

6                   wherein the second tunable coupling member adjusts an amount of  
7       power of the optical signal divided onto the first and second tunable delay  
8       paths of the second differential delay.

1           9.       The filter of claim 8, wherein the second differential delay  
2       includes a fixed portion and a tunable portion.

1           10.      The filter of claim 8, wherein the second differential delay  
2       includes a second fixed differential delay and a second tunable differential  
3       delay with the first and second tunable delay paths.

1           11.      The filter of claim 10, wherein the second fixed differential  
2       delay sets a periodic variation in a power spectrum of the optical signal.

1           12.      The filter of claim 10, wherein the second tunable differential  
2       delay sets a phase of the periodic variation in the power spectrum of the  
3       optical signal.

1           13.      The filter of claim 10, wherein the second fixed differential  
2       delay is positioned between the second tunable coupling member and the  
3       second tunable differential delay.

1           14.     The filter of claim 10, wherein the second tunable differential  
2     delay is positioned between the second tunable coupling member and the  
3     second fixed differential delay.

1           15.     The filter of claim 3, wherein each of the differential delays  
2     is a polarization dependent differential delay.

1           16.     The filter of claim 3, wherein the first fixed differential delay  
2     generates a time delay between first and second polarizations of the optical  
3     signal.

1           17.     The filter of claim 3, wherein the first tunable differential  
2     delay changes an optical phase between first and second polarizations of the  
3     optical signal.

1           18.     The filter of claim 3, wherein the first tunable coupling  
2     member is a polarization state transformer that transform the incoming  
3     signal beam from one polarization state to a different polarization state.

1           19.     The filter of claim 3, wherein the first tunable differential  
2     delay modifies first and second polarizations of the optical signal with  
3     different phase relationships.

1           20.     The filter of claim 3, wherein the first tunable coupling  
2     member includes first and second liquid crystal alignment members coupled  
3     to a voltage source.

1           21.     The filter of claim 20, wherein liquid crystals in the first and  
2     second liquid crystal alignment members are orientated at different angles  
3     with respect to each other.

1           22.    The filter of claim 20 wherein liquid crystals in the first and  
2    second liquid crystal alignment members are orientated at the same angle  
3    with respect to each other.

1           23.    The filter of claim 20, wherein liquid crystals in the first  
2    liquid crystal alignment member are orientated orthogonal to liquid crystals  
3    in the second liquid crystal alignment member.

1           24.    The filter of claim 3, wherein the first tunable differential  
2    delay includes first and second liquid crystal alignment members coupled to  
3    a voltage application member.

1           25.    The filter of claim 24, wherein liquid crystals in the first and  
2    second liquid crystal alignment members are orientated at the same angle.

1           26.    The filter of claim 24, wherein liquid crystals in the first and  
2    second liquid crystal alignment members are orientated at different angles  
3    with respect to each other..

1           27.    The filter of claim 3, wherein at least one of the tunable  
2    coupling members and the tunable differential delays is a liquid crystal  
3    tuning element.

1           28.    The filter of claim 3, wherein at least one of the tunable  
2    coupling members and the tunable differential delays is a Faraday rotation  
3    member.

1           29.    The filter of claim 3, wherein at least one of the tunable  
2    coupling members and the tunable differential delays is an electro-optic  
3    member.

1           30.     The filter of claim 3, wherein at least one of the tunable  
2     coupling members and the tunable differential delays is a thermal tuning  
3     member.

1           31.     A dynamic gain flattening filter configured to receive an  
2     optical signal, comprising:  
3                 a first filter stage including,  
4                 a first tunable coupling member;  
5                 a first differential delay with first and second tunable delay paths;  
6                 wherein the first tunable coupling member adjusts an amount of  
7     power of the optical signal divided onto the first and second tunable delay  
8     paths of the first differential delay and  
9                 a first polarization splitter positioned adjacent to the first filter stage,  
10    the first polarization splitter splitting the optical signal into two orthogonal  
11    polarizations.

1           32.     The filter of claim 31, wherein the first differential delay  
2     includes a fixed portion and a tunable portion.

1           33.     The filter of claim 31, wherein the first differential delay  
2     includes a first fixed differential delay and a first tunable differential delay  
3     with the first and second tunable delay paths.

1           34.     The filter of claim 33, wherein the first fixed differential  
2     delay sets a periodic variation in a power spectrum of the optical signal.

1           35.     The filter of claim 33, wherein the first tunable differential  
2     delay sets a phase of the periodic variation in the power spectrum of the  
3     optical signal.

1           36.     The filter of claim 31, wherein the first polarization splitter is  
2     a polarization walk-off crystal.

1           37.     The filter of claim 31, wherein the first polarization splitter is  
2     a polarization beam splitter.

1           38.     The filter of claim 33, wherein the first fixed differential  
2     delay is positioned between the first tunable coupling member and the first  
3     tunable differential delay.

1           39.     The filter of claim 33, wherein the first tunable differential  
2     delay is positioned between the first tunable coupling member and the first  
3     fixed differential delay.

1           40.     The filter of claim 31, further comprising:  
2            a first half-wave plate positioned between the first polarization  
3     splitter and the first stage.

1           41.     The filter of claim 31 , further comprising:  
2            a second stage including:  
3            a second tunable coupling member ;  
4            a second differential delay with first and second tunable delay paths;  
5     and  
6            wherein the second tunable coupling member adjusts an amount of  
7     power of the optical signal divided onto the first and second tunable delay  
8     paths of the second differential delay.

1           42.     The filter of claim 41, wherein the second differential delay  
2     includes a fixed portion and a tunable portion.

1           43.     The filter of claim 41, wherein the second differential delay  
2 includes a second fixed differential delay and a second tunable differential  
3 delay with the first and second tunable delay paths.

1           44.     The filter of claim 43, wherein the second fixed differential  
2 delay sets a periodic variation in a power spectrum of the optical signal.

1           45.     The filter of claim 43, wherein the second tunable differential  
2 delay sets a phase of the periodic variation in the power spectrum of the  
3 optical signal.

1           46.     The filter of claim 43, wherein the second fixed differential  
2 delay is positioned between the second tunable coupling member and the  
3 second tunable differential delay.

1           47.     The filter of claim 43, wherein the second tunable differential  
2 delay is positioned between the second tunable coupling member and the  
3 second fixed differential delay.

1           48.     The filter of claim 43, further comprising:  
2           a second polarization splitter positioned adjacent to the first stage,  
3           the second polarization splitter combining the two orthogonal polarizations.

1           49.     The filter of claim 48, further comprising:  
2           a first half-wave plate positioned between the first polarization  
3 splitter and the first stage; and  
4           a second half-wave plate positioned between the second walk-off  
5 crystal and the second stage.

1           50.    The filter of claim 48, wherein the first and second  
2   orthogonal polarizations of the optical signal travel independently through  
3   the first and second tunable differential delays.

1           51.    The filter of claim 43, wherein each of the differential delays  
2   is a polarization dependent differential delay.

1           52.    The filter of claim 43, wherein the first fixed differential  
2   delay generates a time differential delay between first and second  
3   polarizations of the optical signal.

1           53.    The filter of claim 43, wherein the first tunable differential  
2   delay changes an optical phase between first and second polarizations of the  
3   optical signal.

1           54.    The filter of claim 43, wherein the first tunable coupling  
2   member is a polarization state transformer that transform the incoming  
3   signal beam from one polarization state to a different polarization state.

1           55.    The filter of claim 43, wherein the first tunable differential  
2   delay modifies first and second polarizations of the optical signal with  
3   different phase relationships.

1           56.    The filter of claim 43, wherein the first tunable coupling  
2   member includes first and second liquid crystal alignment members coupled  
3   to a voltage source.

1           57.    The filter of claim 56, wherein liquid crystals in the first and  
2   second liquid crystal alignment members are orientated at different angles  
3   with respect to each other.

1           58.    The filter of claim 56, wherein liquid crystals in the first  
2 liquid crystal alignment member are orientated at 0 ° and the liquid crystals  
3 in the second liquid crystal alignment member are orientated at 90 °.

1           59.    The filter of claim 43, wherein the first tunable differential  
2 delay includes first and second liquid crystal alignment members coupled to  
3 a voltage application member.

1           60.    The filter of claim 59, wherein liquid crystals in the first and  
2 second liquid crystal alignment members are orientated at the same angle.

1           61.    The filter of claim 59, wherein liquid crystals in the first and  
2 second liquid crystal alignment members are orientated at an orthogonal  
3 angle to each other.

1           62.    The filter of claim 43, wherein each of the tunable coupling  
2 members and the tunable differential delays is a liquid crystal tuning  
3 element.

1           63.    The filter of claim 43, wherein at least one of the tunable  
2 coupling members and the tunable differential delays is a Faraday rotation  
3 member.

1           64.    The filter of claim 43, wherein at least one of the tunable  
2 coupling members and the tunable differential delays is a electro-optic  
3 member.

1           65.    The filter of claim 43, wherein at least one of the tunable  
2 coupling members and the tunable differential delays is a thermal tuning  
3 member.